Canadian Centre for Occupational Health and Safety

Centre canadien d'hygiène et de sécurité au travail

HOW TO WORK SAFELY WITH CORROSIVE LIQUIDS AND SOLIDS

P88-22E

HOW TO WORK SAFELY WITH CORROSIVE LIQUIDS AND SOLIDS

Michael Lowther

Canadian Centre for Occupational Health and Safety

October 1988

CCOHS/CCHST

90-01085/

HOW TO WORK SAFELY WITH CORROSIVE LIQUIDS AND SOLIDS

This publication was prepared as a source of information for health and safety committees and others with an interest in understanding and reducing the occupational hazards of corrosive liquids and solids.

Each publication produced by CCOHS undergoes several stages of review. As a part of this review, representatives from government, employers, and labour are requested to comment on draft copies of CCOHS documents for technical accuracy and readability.

Although every effort is made to ensure accuracy and completeness of the information, it is understood that CCOHS makes no warranty as to the accuracy or completeness of such information and assumes no liability for any damages or loss suffered as a result of any inaccuracy or incompleteness therein.

CCOHS NUMBER P88-22E
ISBN 0-660-12941-8
DSS CATALOGUE NUMBER CC273-2/88-22E

This publication is available in both official languages.

Cette publication est disponible dans les deux langues officielles.

Published 1988

---

250 Main Street East
Hamilton Ontario
L8N 1H6
416-572-2981
FAX 416-572-2206
Telex 061-8532

CCOHS CCHST

TABLE OF CONTENTS

1.	INTRODUCTION	1
2.	WHAT ARE CORROSIVES?	1
3.	HOW ARE CORROSIVES HAZARDOUS?	2
	Health Hazards	2
	Corrosion of Metals	3
	Other Hazards	3
4.	HOW CAN YOU WORK SAFELY WITH CORROSIVE LIQUIDS AND SOLIDS?	4
	Substitute a Less Hazardous Material Where Possible	4
	Use Good Ventilation Wherever Corrosives Are Present	4
	Store Containers of Corrosives Properly	4
	Handle Corrosive Containers Safely	6
	Dispense Corrosive Materials Carefully	7
	Dispose of Waste Material Safely	8
	Practice Good Housekeeping, Personal Cleanliness and Equipment Maintenance	8
	Wear Proper Personal Protective Equipment	9
	Be Ready to Handle Emergencies Safely	10
5.	BASIC SAFE PRACTICES	11
	FURTHER READING	12

CCOHS/CCHST

1. INTRODUCTION

Corrosive materials are present in almost every workplace. Acids, bases (also known as caustics or alkalis), and other chemicals may be corrosive. Everyone who works with corrosives must be aware of their hazards and how to work safely with them.

This publication provides information on how to work safely with corrosive liquids and solids. Much of this advice can also be used to work safely with other hazardous materials.

This guide is intended for workplaces where corrosive liquids and solids are present in storage containers holding 250 litres (55 gallons) or less. It does not cover corrosive compressed gases, bulk storage tanks or piping systems for corrosive materials, or specific processes using corrosives.

Read the container label and the Material Safety Data Sheet (MSDS) before starting to work with a hazardous material. You can obtain the MSDS directly from the material's supplier or manufacturer, or from CCOHS.

Occupational health and safety officials in the jurisdiction where you work can provide information about regulations that must be followed when working with corrosive materials.

2. WHAT ARE CORROSIVES?

Corrosives are materials that can attack and chemically destroy exposed body tissues. They begin to cause damage as soon as they touch the skin, eyes, respiratory tract or digestive tract. Corrosives can also damage or even destroy metal. They might be hazardous in other ways too, depending on the particular corrosive material.

Most corrosives are either acids or bases. Common acids include hydrochloric acid, sulfuric acid, nitric acid, chromic acid, acetic acid and hydrofluoric acid. Common bases are ammonium hydroxide, potassium hydroxide (caustic potash) and sodium hydroxide (caustic soda).

Other chemicals can be corrosive too. Check the supplier labels on chemical product containers. Normally, labels on containers of corrosive materials will have the hazard symbol shown in Figure 1 on them.

It is wise to treat unknown materials as very hazardous until they are positively identified.

Figure 1 - Workplace Hazardous Materials Information System (WHMIS) hazard symbol for corrosive materials

3. HOW ARE CORROSIVES HAZARDOUS?

Health Hazards

Corrosives can burn and destroy body tissues on contact. The stronger or more concentrated the corrosive material is and the longer it touches the body, the worse the injuries will be.

Some corrosives are toxic and can cause other health problems. Check the MSDS and label on the container for warnings of other possible health effects.

Eyes

Corrosive materials can irritate, or in more severe cases, burn the eyes. This could result in scars or permanent blindness.

Skin

Corrosives touching the skin can irritate or even badly burn and blister the skin. Severe corrosive burns over a large part of the body can cause death.

Respiratory Tract

Breathing in corrosive vapours or particles irritates and burns the inner lining of the nose, throat, windpipe and lungs. In serious cases, this results in pulmonary edema, a build-up of fluid in the lungs that can be fatal.

Digestive Tract

Swallowing corrosives burns the sensitive lining of the mouth, throat, esophagus and stomach. In non-fatal cases, severe scarring of the throat may occur. This could result in losing the ability to swallow.

Corrosion of Metals

Many corrosives attack and corrode metals. Contact with corrosives can damage containers, equipment, installations and building components made from unsuitable materials.

When acids attack metals, hydrogen gas is often given off. This is a flammable gas which can burn or explode if an ignition source is present.

Common bases, such as sodium hydroxide and potassium hydroxide, can also attack some metals like aluminum, zinc, galvanized metal, and tin to produce hydrogen gas.

The rate of metal corrosion is greater when the corrosive is stronger and the temperature is higher.

The MSDS for a particular corrosive should explain which metals or other materials, such as plastics or wood, it will attack.

Other Hazards

Some corrosives are also flammable or combustible and can easily catch fire and burn or explode.

Some corrosives are incompatible with other chemicals. They may undergo dangerous chemical reactions and give off toxic or explosive products if they contact each other.

The MSDSs and the labels on the containers should explain all of the hazards for the corrosive materials that you work with.

4. HOW CAN YOU WORK SAFELY WITH CORROSIVE LIQUIDS AND SOLIDS?

Substitute a Less Hazardous Material Where Possible

Substitution can be the best way to avoid or reduce a hazard. Often though, it is not easy or even possible to find a non-corrosive or less corrosive substitute to do the job effectively and safely. Start by obtaining the MSDSs for all possible substitute materials. Find out about all of the hazards (health, fire, chemical reactivity) of these materials before making any changes.

Choose the least hazardous materials that can do the job effectively and safely. Learn how to work safely with them, too.

Use Good Ventilation Wherever Corrosives Are Present

Well-designed and -maintained ventilation systems remove corrosive vapours, fumes, mists or airborne dusts from the workplace and reduce their hazards.

The amount and type of ventilation needed to minimize the hazards of airborne corrosives depends on such things as the kind of job, the kind and amount of materials used, and the size and layout of the work area.

An assessment of the specific ways corrosives are stored, handled, used, and disposed of is the best way to find out if existing ventilation controls (and other hazard control methods) are adequate.

Some workplaces may need a complete system of hoods and ducts to provide acceptable ventilation. Others may require a single, well-placed exhaust fan. No special ventilation system may be needed when working with small amounts of corrosives which do not give off airborne contaminants.

Use corrosion-resistant construction in ventilation systems for corrosive materials.

Store Containers of Corrosives Properly

Before storing corrosives, inspect all incoming containers of corrosives to ensure that they are undamaged and properly labelled. Do not accept delivery of defective containers.

Corrosives can destroy containers made of improper materials. Be sure to store corrosive materials in the type of containers recommended by the manufacturer or supplier. Protect containers against banging or other physical damage when storing, transferring, or using them. Keep them tightly closed when not in use.

Storage Area

In general, store corrosives separately, away from processing and handling areas, and from other materials. Separate storage can reduce the amount of damage caused in case of fires, spills or leaks. If totally separate storage is not possible, store corrosives away from incompatible materials.

Some corrosives are incompatible with each other. For example, acids and bases react together, sometimes violently. Do not store them beside each other.

Walls, floors and shelving in corrosive storage areas should be made from materials that resist attack by corrosives. Floors in areas where liquid corrosives are stored should not allow liquids to penetrate. Since many corrosive liquids flow easily, store them in corrosion-resistant trays to contain spills or leaks. For large containers, such as 250 litre-(55 gallon-) drums, provide dikes around liquid storage areas and sills or ramps at door openings.

Store containers at a convenient height for handling, below eye level if possible. High shelving increases the risk of dropping containers and the severity of damage if a fall occurs.

Store corrosives in areas which are:

- well ventilated.
- supplied with adequate firefighting equipment.
- supplied with suitable spill clean-up equipment and materials.
- labelled with proper warning signs.

Storage Temperature

Store corrosives in dry, cool areas, out of direct sunlight and away from steam pipes, boilers or other sources of heat. If a sealed full drum or carboy of a corrosive liquid is stored in direct sunlight or near other heat sources, vapour levels in the container can build up. This leads to an increase in pressure in the container. In severe cases, this could cause the container to rupture. A build-up of pressure might also result in the material shooting out into the face of the person opening the container.

Follow the chemical manufacturer's or supplier's recommendations for storage temperature. Where appropriate, store corrosive liquids at temperatures above their freezing (melting) points. Acetic acid, for example, has a freezing point of approximately 17°C (63°F) and can freeze in an unheated room. As it freezes, it expands and can crack a glass container.

Avoid rapid temperature changes in corrosive liquid storage areas. If a tightly-sealed corrosive liquid container is cooled suddenly, a partial vacuum could form inside it. In extreme cases, the container might collapse and leak.

At all times:

- allow only trained, authorized people into storage areas.
- keep the amount of corrosive material in storage as small as possible.
- inspect storage areas regularly for any deficiencies, including corrosion damage, leaking containers, or poor housekeeping. Correct all deficiencies as soon as possible.

Handle Corrosive Containers Safely

Always handle containers of corrosives carefully. Damaged containers may leak.

Many workplaces receive corrosive liquids in large metal drums or barrels and fill smaller containers from them. Moving full drums weighing hundreds of pounds by hand can be difficult and hazardous. Drums can be moved in specially designed drum cradles which can also be used as individual drum storage racks. You can also purchase special carboy caddies for bulky bottles of corrosives and safety bottle carriers for smaller-sized bottles of corrosives. Safety equipment and laboratory supply retailers sell this equipment.

Self-closing, portable containers for carrying, storing, and dispensing small amounts of corrosive liquids are also available. They are made from high density polyethylene and come in different shapes with capacities up to 19 litres. These containers have spring-mounted spout caps that close automatically when you finish filling or pouring from the container, or if they are dropped. They also automatically open when the vapour pressure builds up inside, to allow vapours to escape and prevent rupture.

Acid Container Rupture

Acid containers, such as drums and carboys, can cause particular problems if they are not handled and stored safely. Injuries have resulted from sealed acid drums and carboys that ruptured or burst. There are many reasons why these containers rupture:

- Heat can cause vapour levels inside a sealed container to build up to the point where the container bursts. This is more likely to happen if the drum is overfilled to begin with.

- Chemicals stored in a metal drum might react with the metal and form hydrogen gas which could ignite when the drum is opened.

- The drum may not have been cleaned thoroughly before it was filled. If the previously-stored chemical is incompatible with the corrosive, chemical reactions could cause the drum to explode.

- Air or inert gas pressure used to empty the drum may cause weakened or damaged drums to burst.

To avoid bursting or rupturing, acid drums may need to be vented periodically. This is done by carefully loosening a closure plug to relieve any build-up in pressure. The MSDS may say whether drums of a particular liquid need to be vented and, if so, how often. To be sure whether drums of acids must be vented and for specific directions about how to vent, contact the chemical manufacturer or supplier.

Venting should only be done by trained people, using the right tools and wearing the proper personal protective equipment. If any swollen drums of chemicals are seen, contact the chemical manufacturer or supplier immediately for assistance. Handling swollen chemical drums is a very hazardous job that often requires special procedures and equipment to be done safely.

Always:

- make sure that containers of corrosives are kept tightly closed except when the materials are actually being used.
- keep only the smallest amounts possible of corrosives in work areas.
- check that all corrosive containers are properly labelled, and handle containers so that the label remains undamaged and easy to read.

Dispense Corrosive Materials Carefully

Take care when dispensing or transferring corrosives from one container to another. Dispense from only one container at a time. Finish all the dispensing of one material before starting to dispense another. Be sure containers are closed after dispensing.

Handle corrosives so that dusts, mists, vapours, or fumes do not get into the air. Be very careful when transferring from larger containers into smaller ones. Many injuries have been caused by spillage from open, unstable, or breakable containers during material transfer.

If liquid corrosives are stored in drums, use a corrosion-resistant drum pump for transferring liquids into other containers. Pumps are also available for dispensing corrosive liquids from most sizes and types of the supplied containers. Do not transfer liquids by pressurizing their usual shipping containers with air or inert gas. Ordinary drums and barrels may be damaged by the pressure. Never pipette corrosive liquids by mouth. Use a pipette bulb or aspirator instead.

Transfer corrosive solids using tools like scoops or shovels that are corrosion resistant.

Addition of Corrosives to Water

Sometimes, a job requires mixing corrosives with water. Many corrosive materials, both liquid and solid, generate large amounts of heat when they are mixed with water. This can cause the solution to froth and boil or even to erupt violently from the container. For example, a glass of water thrown into a bucket of concentrated sulfuric acid is converted instantly

to steam which will eject the entire contents of the bucket into the air. For this reason, always add corrosives to water, slowly, in small amounts, with frequent stirring. Always use cold water.

Dispose of Waste Material Safely

Corrosive wastes are hazardous and must always be handled safely.

All containers for corrosive wastes must be made from corrosion-resistant materials. Identify the contents of these containers with suitable labels.

"Empty" drums, bottles and other containers often have hazardous corrosive residues inside them. Never use these "empty" containers for anything else, no matter how clean they seem to be. Treat them as corrosive wastes. It may be possible to safely decontaminate "empty" containers. The chemical manufacturer or supplier can give advice about this.

Never dispose of corrosives down sinks or drains that connect to sanitary or storm sewers. Dispose of them according to the manufacturer's or supplier's directions, or through hazardous waste collection and disposal companies. In all cases, dispose of corrosive wastes according to the environmental laws that apply to your jurisdiction. Contact the appropriate environmental officials for details about the disposal laws that apply for specific corrosives.

Practice Good Housekeeping, Personal Cleanliness and Equipment Maintenance

Good housekeeping, personal cleanliness and equipment maintenance are important wherever any chemicals, including corrosives, are used.

Good Housekeeping

Maintain cleanliness and order at all times in the workplace:

- Clean up any spills and build-ups of corrosives promptly and safely.
- Properly dispose of unlabelled or contaminated chemicals.
- Remove empty containers at once from work areas.
- Ensure that all containers for waste are properly marked and easily located.

Personal Cleanliness

Personal cleanliness is a very important way of protecting personnel working with hazardous chemicals.

- Wash hands before eating, drinking, smoking or going to the toilet.
- Remove and clean contaminated clothing before wearing it again, or discard it.
- Do not smoke, drink, chew gum or eat in any areas where hazardous chemicals are present.

- Store food and tobacco products in uncontaminated areas.
- Avoid touching yourself with contaminated hands.
- Clean yourself thoroughly at the end of the workday.

Equipment Maintenance

Regular maintenance of equipment is important in preventing leaks or emissions of corrosives into the workplace.

- Ensure maintenance personnel know the possible hazards of the materials they might be exposed to.
- Be sure they know any special procedures and precautions that might be needed before they begin to work on equipment.

Regular workplace inspections can help in spotting areas where health and safety problems may be developing.

Wear Proper Personal Protective Equipment

If other methods, such as engineering controls, are not available or effective enough to control exposure to corrosives, wear suitable personal protective equipment (PPE). Choosing the right PPE to wear when doing a particular job is essential. MSDSs should provide general guidance. Selecting PPE for a specific job is best done with the help of someone who knows how to evaluate the hazards of the job and how to select the proper PPE.

Avoid Skin Contact

Wear protective gloves, aprons, boots, hoods, or other clothing depending on how much chance there is of skin contact. This clothing must be made of materials that resist penetration or damage by the chemical. The MSDS should recommend appropriate materials. If it does not, contact the chemical's manufacturer or supplier for specific information.

Protect Your Eyes and Face

Always wear eye protection when working with corrosives. Although ordinary safety glasses provide some protection, chemical safety goggles are best. In some cases, you should also wear a face shield to protect your face from splashes. The current Canadian Standards Association (CSA) Standard Z94.3, "Industrial Eye and Face Protectors," provides advice on selection and use of eye and face protectors.

Avoid Breathing Corrosive Vapours, Fumes, Dusts or Mists

If respirators must be used for breathing protection, there should be a written respiratory protection program to follow. Guidance for developing a program can be found in the current CSA Standard Z94.4, "Selection, Care, and Use of Respirators." Follow all legal requirements for respirator use and approvals. These may vary between jurisdictions in Canada.

Know and be familiar with the right PPE for emergencies, as well as normal operations.

You must wear the PPE needed for doing a particular job. PPE cannot protect you if it is not worn.

Be Ready to Handle Emergencies Safely

In emergencies like chemical fires, leaks and spills, act fast.

- Evacuate the area at once if you are not trained to handle the problem or if it is clearly beyond your control.
- Alert other people in the area to the emergency.
- Call the fire department immediately.
- Report the problem to the people responsible for handling emergencies where you work.
- Obtain first aid if you have been exposed to harmful chemicals. The MSDS and container label for a particular corrosive should give specific first aid instructions in case of exposure by skin or eye contact, inhalation, or swallowing.

Most workplace injuries caused by common corrosives, such as acids and bases, result from accidental skin or eye contact. Usually in these cases, the following basic first aid procedures apply:

- Skin contact: As quickly as possible, remove contaminated clothing and flood the exposed skin with water for at least 15 minutes. Obtain medical attention immediately except for minor cases of skin contact.
- Eye contact: As quickly as possible, flood the affected eye(s) thoroughly with large amounts of gently flowing water for at least 15 minutes. Obtain medical attention immediately.

Emergency eyewash stations and safety showers should be present wherever accidental exposure to corrosives might occur. These are available from safety equipment retailers.

Only specially trained people, equipped with the proper tools and protective equipment, should handle the emergency. Nobody else should go near the area until it is declared safe.

Planning, training and practicing for emergencies are important so that everyone knows what they must do.

The MSDSs for the materials you are using on each job are a good starting point for drawing up an emergency plan. MSDSs have specific sections on fire and explosion hazards, including suitable fire extinguishing equipment and methods, spill clean-up procedures and first aid instructions. If the directions in each MSDS section are not clear or seem incomplete, contact the material's manufacturer or supplier for help.

You can obtain help in developing emergency plans from many other sources too. Local fire departments can assist with fire emergency plans and training. Occupational health and safety and environmental enforcement agencies, provincial safety associations, St. John Ambulance, insurance carriers, professional societies in occupational health and safety, labour unions, trade associations, some local colleges and universities, and CCOHS can supply useful information at little or no cost. Specialized private consultants are also available.

5. BASIC SAFE PRACTICES

Following these basic safe practices will help protect you from the hazards of corrosive materials:

- Obtain and read the Material Safety Data Sheets (MSDSs) for all of the materials you work with.
- Be aware of all of the hazards (fire/explosion, health, chemical reactivity) of the materials you work with.
- Know which of the materials you work with are corrosives.
- Store corrosives in suitable labelled containers away from incompatible materials, in a cool, dry area.
- Store, handle, and use corrosives in well-ventilated areas.
- Handle containers safely to avoid damaging them.
- Dispense corrosives carefully and keep containers closed when not in use.
- Stir corrosives slowly and carefully into cold water when the job requires mixing corrosives and water.
- Handle and dispose of corrosive wastes safely.
- Practice good housekeeping, personal cleanliness and equipment maintenance.
- Wear the proper personal protective equipment for each of the jobs you do.
- Know how to handle emergencies (fires, spills, personal injury) involving the corrosive materials you work with.
- Follow the health and safety rules that apply to your job.

Call the CCOHS Inquiries Service at 1-800-263-8276 if you need more information about how to work safely with corrosives.

FURTHER READING

Bahme, C.W. Fire officer's guide to dangerous chemicals. 2nd ed. Boston, Massachusetts: National Fire Protection Association, 1978.

Clisby, A.C. et al. Acid hazards. Fire. (Nov. 1964). p. 293, 296, 302.

Controlled Products Regulations, (1987) 122 Canada Gazette Part II 551, 1987 12 31.

Fire protection handbook. A.E. Cote et al., editors. 16th ed. Quincy, Massachusetts: National Fire Protection Association, 1986.

Hodnick, H.V. Are you handling acid drums and carboys safely? Occupational Hazards. (August 1962). p. 34-37.

National fire code of Canada. 5th ed. Ottawa: National Research Council of Canada, 1985.

Safety with corrosive chemicals. Wellington, New Zealand: Department of Labour, 1984.

Sax, N.I. Dangerous properties of industrial materials. 3rd ed. New York: Van Nostrand Reinhold Company, 1968. p. 211-212.